The strobe "kill" light on the vehicle in the foreground is illuminated, indicating it was a victim of the MILES. BLUFOR M1 MBTs and BFVs were equipped with laser sensors to record "hits" and "kills" which would eliminate them from the battle.

Air Force fixed wing aircraft that provided close air support during the training exercises, were instrumented.[69] By 1993, MILES was available for the M1 and M1A1 Abrams tank; the M2/3 Bradley fighting vehicles; and the Stinger air defense systems. Also provided with MILES were the AH-1 Cobra, the OH-58 Kiowa, and the BLUFOR UH-1 Huey helicopters, as well as several U.S. Air Force A-10 fixed wing aircraft.[70]

The development and fielding of the MILES for aviation and air defense systems, called the Air Ground Engagement System/Air Defense, or AGES/AD, received high priority as the NTC matured. AGES/AD was

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69. The role of the U.S. Air Force during the early days of the NTC is discussed in Vol I, pp. 129-139. The Air Force role at the NTC, 1984-1993 is discussed in Chapter VII of this study.

70. (1) TRADOC Annual Command History, CY 1990, p. 185. (2) Information Paper, TRADOC Commander's Conference, 26-29 Nov 84. MILES was not only used at the CTCs, but throughout the Army for homestation training.

designed to simulate, in real time, the effects of Army helicopters in tactical engagements with ground weapons systems. The AGES/AD equipment was attached to the aircraft platform of the AH-1 Cobra, UH-1 Iroquois/ Huey, and the OH-58 Kiowa helicopters. The MILES detector harness on all three aircraft enabled the instrumentation system to reflect the results of surface-to-air attacks. MILES transmitters on the Cobra were capable of attacking dismounted and mounted soldiers on the ground. The Huey, when equipped with M60 machine guns, could also engage ground targets. The AGES/AD system was fielded only to the NTC, the Joint Readiness Training Center, and the Combat Maneuver Training Center.[71]

As important as the MILES was to the creation of a realistic training environment, the system was far from perfect. Its laser beam could be weakened by fog or rain. The lasers more often than not could not penetrate dust, smoke, or camouflage netting. Soldiers could protect themselves from a MILES death behind foliage too light to do the job against real bullets. Not enough aircraft were instrumented to satisfactorily replicate the third dimension of the battlefield. And most important of all, MILES could not simulate the effects of indirect fire (artillery, mortars, mines, and certain unconventional [biological, chemical] weapons). For those reasons, and because "upgrades" had been planned since the NTC concept was approved, beginning early in 1985 the Army developed two programs known as MILES II and MILES AGES II to cure the existing ills of the system and to provide MILES devices for the UH-60 (Blackhawk), AH-64 (Apache), CH-47D (Chinook), and OH-57D (Kiowa Warrior) aircraft. While the original MILES unit could transmit only 37 weapons codes, which supported the determination of kill or near miss firings, MILES II would have a projected 5,280 codes.[72]

The aforementioned difficulty at the NTC in assessing the effects of indirect fire had long been a major problem for Army trainers, for reasons of safety and a lack of technology. The fundamental problem was that the parabolic arc of an artillery round was not easily simulated by laser pulses, which in any case had to be limited in power lest they damage the retinas of troops on the battlefield. The indirect fire assessment system in place at the NTC in late 1984 featured fire markers who assessed casualties

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71. (1) TC 25-6, Force on Force Collective Training Using the Tactical Engagement Simulation Training System, Headquarters, Department of the Army, 7 Feb 94, 2-16 to 2-17 [hereafter cited as TC 25-6 Force on Force]. (2) Tactical Engagement Simulation Training System Master Plan, Vol. I, Management, May 1993, pp. 5-4 to 5-5 [hereafter cited as TES Master Plan].

72. (1) TC 25-6, Force on Force, pp. 2-14 to 2-15. (2) TES Master Plan, pp. 5-2 to 5-3.

A 4th Infantry Division tank commander searches the desert for the OPFOR. The .50-caliber machine gun on his cupola is fitted with a blank firing device. If his M1 was "hit," the strobe light to his left would flash.

using fixed kill probability tables and pyrotechnic devices. Firemarkers (O/Cs) in jeeps[73] with radios and "manpacks" (portable position location devices) passed along a call for fire to the central NTC computer where it was entered into the MILES. When the mission was fired, the computer analyst could see the strike of the rounds and dispatch the firemarker to the area to give the artillery signature and determine casualties. The firemarker O/Cs then used their MILES "God guns" to put any men or vehicles declared killed, out of action. The firemarker system was slower than actual fires. In addition, the actual suppression value of artillery did not affect maneuver operations. In essence, combat arms, combat support and combat service support elements trained in an environment devoid of indirect

73. Later in the 1980s, fire markers' vehicles were HMMWVs.

fire effects. Senior Army officials believed improvement was vital because even in an era of "smart" weaponry, land battle still depended on artillery.[74]

As time went on and no better system was found, complaints increased. Members of Congress began asking whether the NTC was living up to its full potential; were the enormous costs justified? Senior Army leaders became seriously concerned about the deficiency in Army training and about the future of the NTC. Field artillery officers complained that field artillery was not allowed to "play" in force-on-force maneuvers. In an effort to solve the problem, representatives of the Field Artillery School, the TRADOC Systems Manager for the NTC, the AMC Program Manager for Training Devices, and the Jet Propulsion Laboratory formed a joint study group and designed a program to develop what they called the Simulation of Area Weapons Effects-Radio Frequency (SAWE-RF). The SAWE device, tested at Fort Hood in 1983, employed pneumatic propulsion to launch styrofoam balls which were designed to burst at 20 meters in the air. The SAWE program immediately came under harsh criticism. TRADOC commander, General William R. Richardson insisted a system usable throughout the Army should be developed. Brig. Gen. Thomas F. Cole, the NTC commander, questioned the operational feasibility of the system. The Assistant Secretary of the Army (Research, Development, and Acquisition) Jay R. Sculley staunchly defended the SAWE program. SAWE remained controversial and development was slow. Meanwhile, to quiet increasingly loud criticism, Sculley directed that something, even a partial solution, be developed to allow indirect fire play at the NTC. In response, TRADOC began concept development for an "NTC unique" interim system to simulate artillery fire until an objective system was available. The system finally put in place temporarily was known as the Combined Arms Training Integrated Evaluation System, always called CATIES.[75]

The story of the development, testing, and fielding of CATIES, beginning in 1983, is representative of the difficulties the Army, and especially the NTC, has long had in the procurement of new systems, be it for training or combat. The Field Artillery School explained that any device to simulate fire support had to be compatible with already fielded tactical engagement systems. After a search for the right device, the school selected CATIES, which was proposed by LB&M Associates and developed by Motorola beginning in 1985. The CATIES concept depended on line-of-sight radio frequency triangulation (Chart 5).

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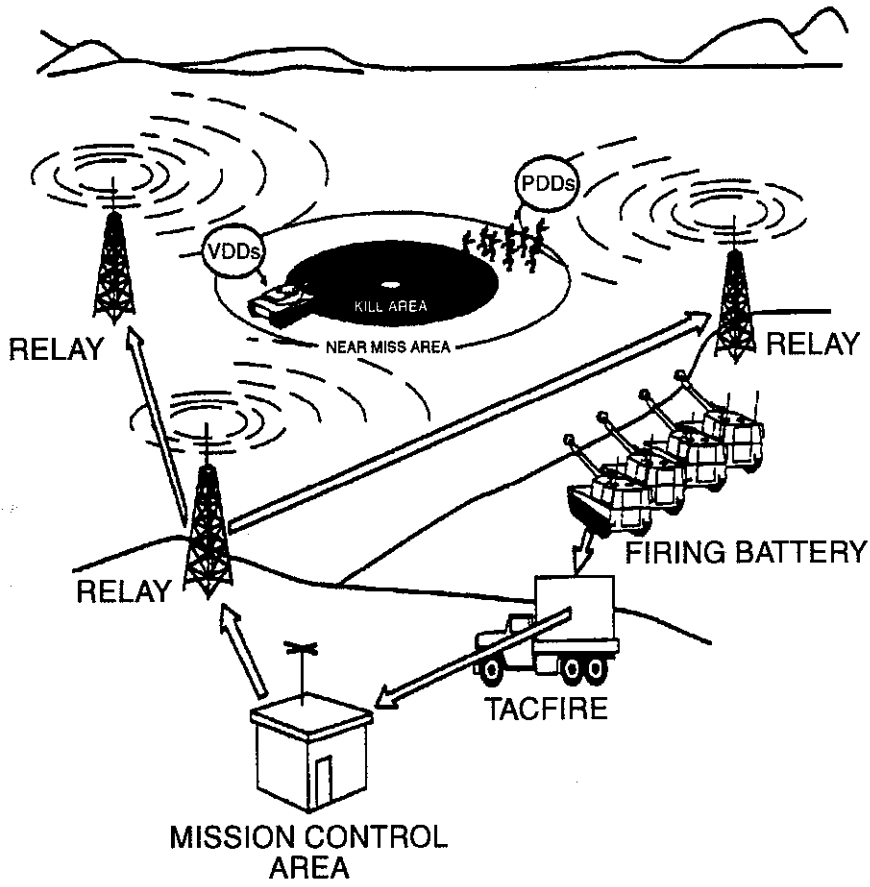
74. Don Zorpette, "Emulating the Battlefield," *IEEE Spectrum*, September 1991, p. 36.

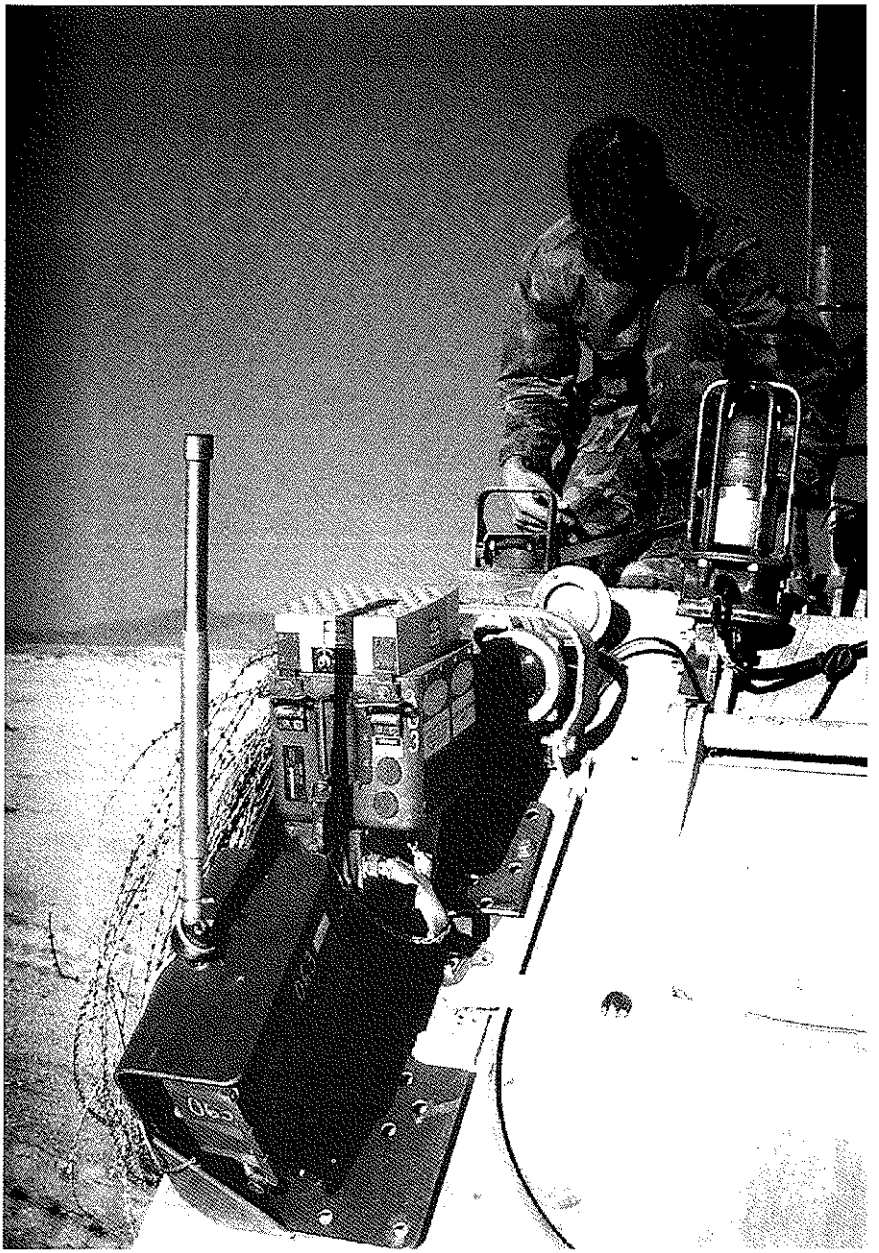
75. A detailed description of indirect fire simulation in the NTC's early days is in NTC, Vol I, pp. 75-79. Alternatively, the "T" in CATIES stood for "Team."

Chart 5
CATIES Indirect Fire Simulation

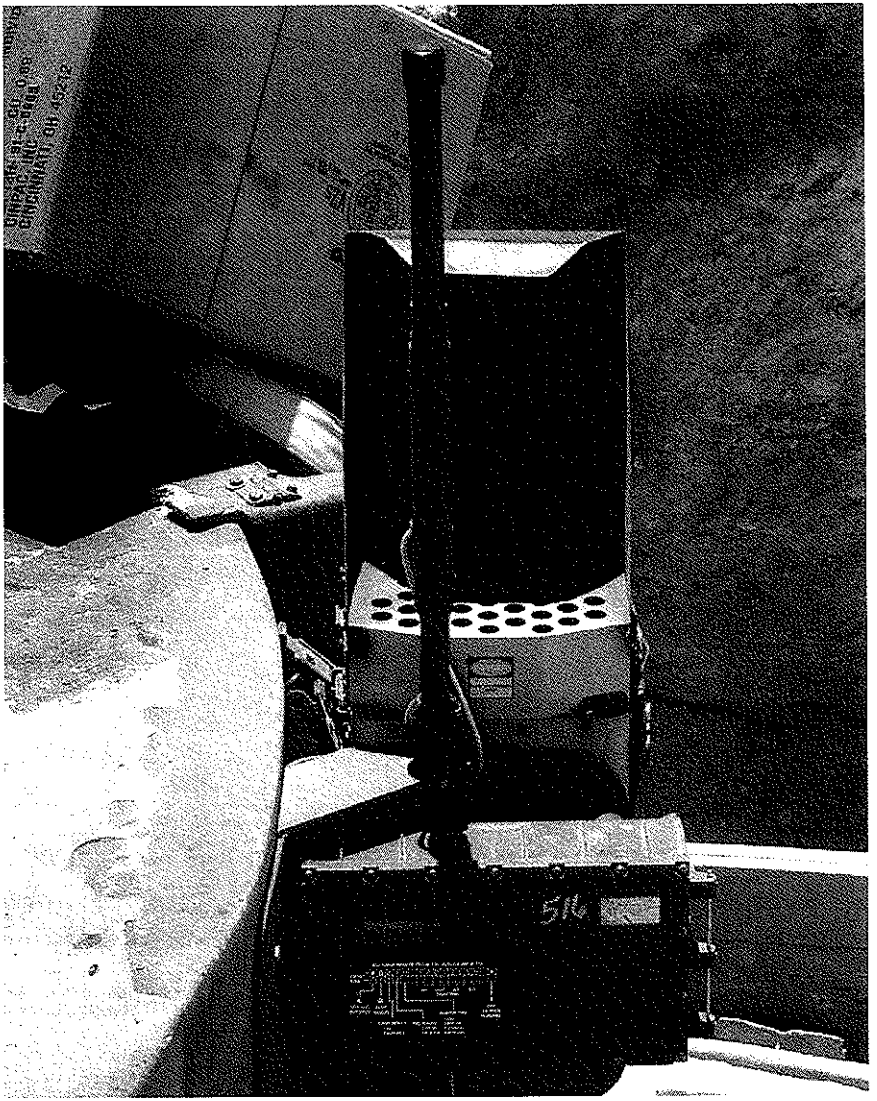


PDD - Player Detection Devices
VDD - Vehicle Detection Devices

Source: Headquarters, Department of the Army, Training Circular 25-6, Draft (Washington, D.C., 7 Feb 1994), p. 3-8.



The controversial Combined Arms Training Integrated Evaluation System, or CATIES (above and right), *was designed to provide an interim capability to simulate, in real time, indirect fire and chemical contamination effects on personnel and vehicles at the NTC.*



The system consisted of a small box that carried 60, 12-gauge shotgun shells and was mounted on the rear of a vehicle. When artillery was fired, training analysts in the Star Wars building at Fort Irwin's main post, sent out a signal to radio towers in the training area. The radio towers painted a signature where artillery was being fired. If personnel drove into that area, an antenna on the vehicle picked up a code that registered what type of ammunition was used and the number of rounds fired. Programmed into the computer was what kind of vehicle the antenna was on. Then the

computer fired the shotgun shells that emitted both an explosion and a white puff of smoke. A cable hooked the box to the MILES, thereby causing the strobe light to go on, indicating the player died as a result of artillery fire.[76]

On 29 September 1986, the Field Artillery School contracted with Motorola to perform a concept evaluation of CATIES, which led to a "proof of principle" test at Fort Sill in July 1987. After follow-on tests at the NTC, Fort Chaffee, and Fort Hunter Liggett, Army Chief of Staff Vuono conditionally accepted CATIES on 31 May 1988. However, continuing technical problems with frequency interference with other equipment and terrain line-of-sight limitations convinced the Chief of Staff to restrict the use of CATIES to the NTC and simultaneously to continue development of the Simulated Area Weapons Effects-Radio Frequency (SAWE-RF) based on the rapidly advancing technology of the Global Positioning System (GPS). The program, then known as SAWE-RF/GPS, was designed to provide simulation of indirect fire throughout the Army. The Army deferred, however, a fielding decision for CATIES until 1990 and for SAWE-RF/GPS until 1991. That decision left open the question of whether CATIES would eventually be replaced by SAWE-RF or would it continue to operate at the NTC while the other two maneuver training centers received SAWE-RF/GPS?[77]

The CATIES program had faced an uncertain future from the beginning. It was fraught with cancellations and delays. On 30 January 1989, Motorola received a sole source contract for CATIES with fielding scheduled for between October 1989 and April 1990. The sole source decision was based on the Army's perception that fielding an adequate indirect fire simulation system was urgent. However, earlier—on 11 January 1989—the Department of Defense Inspector General (DOD-IG) had announced an audit of the procurement process, in response to a complaint that irregularities had occurred during the contract award process. After a three-month investigation, the Inspector General recommended the Army immediately cancel the CATIES contract. His decision was based not only on the presence of irregularities in the sole source contract, but on the belief that CATIES would not meet the Army's requirements and that it was not cost-effective since it duplicated the functions of the SAWE-RF/GPS. Assistant Secretary Sculley in his nonconcurrence issued a memorandum charging the IG

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76. (1) Boyd Dastrup, Field Artillery branch historian and Larry Kaplan, Asst Field Artillery historian, in Field Artillery Annual Command History, CY 1990, pp. 80-84. (2) Briefing, Brig. Gen. William G. Carter III, Fort Irwin Calif., 1992.

77. (1) Dastrup and Kaplan, CY 1990, pp. 84-85. (2) Fact Sheet ATSF-DVT, Larry Graham, 30 Mar 90, subj: Combined Arms Team Integrated Evaluation System (CATIES).

with failing to establish objective grounds for his recommendation. Sculley also explained that terminating CATIES "would leave the Army with *no* capability for addressing a serious training deficiency" until 1992 when SAWE-RF/GPS was expected to be fielded.[78]

In late August 1989, the IG retracted his recommendation for ending the CATIES program, but warned the Army to provide better oversight. His concession to the Army came with strings attached to prevent cost overruns. The IG and the Undersecretary of Defense (Acquisition) would have to approve the Army's exercise of contract options. That approval would only be granted in the event there were significant delays in the fielding of SAWE-RF/GPS.[79]

The CATIES program stumbled along. In September 1989, Secretary of the Army Michael P. W. Stone visited the NTC and expressed his serious doubts about CATIES. The Secretary questioned whether the Army should continue to spend money on the program. After further scrutiny of the CATIES development process, Sculley revalidated the value of CATIES as an interim system and again stressed the urgency of correcting training deficiencies. Even with that renewed support, CATIES continued to suffer setbacks in fielding on schedule to the NTC. Contract modifications and negotiations between the Army and Motorola caused delays, which threatened to lead to the cost overruns the Department of Defense IG was so anxious to avoid. The commandant of the Field Artillery School blamed the Army's system of writing, negotiating, and executing contracts. The Army Materiel Command agreed and added that the totally unrealistic proposal Motorola had submitted in October 1988 had caused lengthy negotiations that drove the cost up drastically, given that CATIES was only an interim program. In addition, the contract classified some essential CATIES equipment—such as player detection devices—as optional purchases outside of the original contract. Funding shortages for maintenance and technical difficulties at the NTC caused the negotiated delivery date for fall 1989 to slip into 1990.[80]

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78. (1) Dastrup and Kaplan, CY 1990, pp. 85-86. (2) Memorandum for the Inspector General , Department of Defense, subj: Draft Quick Reaction Report on the Audit of CATIES, 6 Jun 89.

79. Dastrup and Kaplan, CY 1990, p. 87. Simultaneously with the CATIES effort, the NTC was upgrading the instrumentation system and preparing to move the Operations Group into a new operations center. That project was already behind schedule and had suffered serious cost overruns. The instrumentation system and its upgrade are discussed below.

80. (1) Dastrup and Kaplan, CY 1990, pp. 87-88. (2) Fact Sheet ATSF-DVT, Larry Graham, 20 March 1990, subj: Combined Arms Team Integrated Evaluation System.

The NTC planned a demonstration of the CATIES system for Army Chief of Staff Vuono and General Edwin H. Burba, Jr., FORSCOM commander, at Fort Irwin in April 1990. But by early March, Motorola had experienced so many technical difficulties with the system that the CATIES project manager voiced his concern that a safe demonstration had little chance for success. Scheduled hardware deliveries were forty days in arrears; software testing scheduled to begin in February 1990 had not begun; testing on the vehicle detection devices had been suspended in March; and safety testing of the audio-visual cuing devices and the pyrotechnic cartridges was behind schedule. However, because government acceptance tests were critical to the future of the program and because the Secretary of the Army planned to make a decision in November on purchase of the critical player detection devices, enough of the CATIES systems were completed for a successful test for Generals Vuono and Burba on 17 April 1990.[81]

Two weeks later, CATIES was in trouble again when Motorola reported spectrum frequency difficulties at the NTC and the failure of a subcontractor to deliver parts on time. The primary contractor maintained that only 200 of the 600 vehicle detection devices required for acceptance testing during Rotation 90-10, beginning 1 June, could be delivered. That situation meant that force-on-force training with CATIES could only be partially assessed. It also meant that the firemarker system and the new CATIES system would both have to be used to simulate indirect fire, an arrangement likely to cause confusion for the rotating units. The Army responded immediately to Motorola's latest delays by issuing a "cure notice" specifying failures and shortfalls that Motorola had to remedy within ten days, or the Army would consider invoking the contract's default clause and terminating the contract. Maj. Gen William F. Streeter, whose 1st Cavalry Division was scheduled for Rotation 90-10 during the CATIES test, argued that the Army ought to go ahead with the test with whatever CATIES systems could be fielded so the system could be worked with. General Burba, who had favored quick fielding of CATIES after the April demonstration, now recommended postponement until the contractor could find solutions to the problems. But such an approach threatened to negatively influence the upcoming Secretary of the Army decision on purchase of the player detection devices.[82]

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81. Dastrup and Kaplan, CY 1990, p. 89.

82. (1) Dastrup and Kaplan, CY 1990, pp. 90-91. (2) Memo, Maj. Gen. Streeter to Maj. Gen. Raphael J. Hallada, 16 May 90, subj: CATIES Briefing to 1st Cav Div.

In answer to the "cure notice," on 14 May 1990, Motorola assured the government it intended "to deliver the required material and data as quickly as possible with no apparent damage to the Government." The government was not entirely reassured, and the search went on for an acceptable solution. Meanwhile the Army looked to safeguard the optional purchase of the player detection devices. 16 May 1990, the Office of the Assistant Secretary of the Army requested authorization to exceed the funding ceiling for CATIES and exercise the option to buy the devices. Project representatives warned, however, that in light of Motorola's poor performance, costs should be "definitized." Two weeks later, on 1 June as scheduled, the NTC began conducting the CATIES acceptance test. By that time Motorola had exceeded its own estimate of how many CATIES it could field (200) and managed to outfit about 400 vehicles. At first all seemed well, and General Vuono was pleased with the preliminary testing. However, after action reviews, examination of the files created by computers in the Operations Center, and continued testing revealed flaws in CATIES that Motorola was unable to correct. As a result, on 8 June the NTC suspended the tests to give Motorola time to correct the technical problems before testing resumed. Because of ongoing upgrading of the NTC instrumentation, CATIES testing could not resume until late September during Rotation 90-14, the last rotation of the fiscal year.[83]

Senior NTC officials, and especially NTC commander Brig. Gen. Wesley K. Clark, were anxious to integrate CATIES into the center's combined arms training. Essential to that action was the purchase of the elusive player detection devices before testing continued. Clark pointed out that increased emphasis on heavy/light and contingency operations made instrumenting individual players for CATIES more important than ever. Testing, however, did not resume in September, because technical problems remained unresolved and because of the disruption of the NTC rotation schedule as Army units deployed to Operation Desert Shield. The final tests were rescheduled for January 1991. That necessity meant that the decision on purchase of the player detection devices would be made before the tests were completed. In November, as expected, the Inspector General's office asked the Army for a decision on the 3,500 devices. The Army had planned to make that decision just after testing was completed in September 1990. Now the service was faced with inconclusive test results and a late January 1991 expiration date on the option to purchase. At that time the NTC had only sixteen prototype player detection devices, just delivered for

83. Dastrup and Kaplan, CY 1990, pp. 92-93.

validation—7 months late and in need of redesign. In view of that situation, Stephen Conver, then Assistant Secretary of the Army (Research, Development, and Acquisition), recommended the option be allowed to expire, since it would be May-June 1992 at the earliest before production deliveries of the player detection devices could be made. In any case, SAWE-RF/GPS was expected to be fielded in the March-April 1993 time frame, and it did not make sense to cling to an unfunded and unpriced option for an interim system. The player detection option was, therefore, allowed to expire. The sixteen prototypes were stored, and successful final testing took place in January-February 1991 using only vehicle detection devices. To make up for the lack of ability to instrument individual players, the fire marker system was continued along with CATIES.[84]

As complaints about CATIES continued, development of the objective Simulated Area Weapons Effects-Radio Frequency program moved forward. After fielding of the Global Positioning System in 1988, SAWE developers decided to take advantage of the new technology. At that time the efforts to simulate indirect fire became SAWE-RF/Global Positioning System. On 31 July 1989, the Army awarded the SAWE-RF/GPS contract to Loral, the same corporation that had developed MILES I and was developing the more sophisticated MILES II. Fielding at that time was set for mid-1992. Plans were for fielding the indirect fire simulation system in four phases, CATIES being the first. Next SAWE-RF would replace CATIES at the NTC and be fielded at the other two combat maneuver training centers. During phase three, SAWE-RF/GPS would be fielded worldwide. Contractor logistics support for the fielded systems was to be the final phase.[85]

The GPS-based system was similar in concept to CATIES, except that the newer system would simulate the effects of mines, in addition to those of artillery and mortar fire and chemical weapons. When the system was fully fielded, calls for fire would be entered into a mission control station (MCS) computer, and the computer would calculate the impact area and the kill and near-miss patterns of the calls for fire (Chart 6). A radio frequency transmission would broadcast the simulated weapons casualty effects to all SAWE-RF player units. Individual soldiers and vehicles determined whether they were in the engagement area and thus vulnerable to the simulated barrage, by using a locally determined GPS position. The

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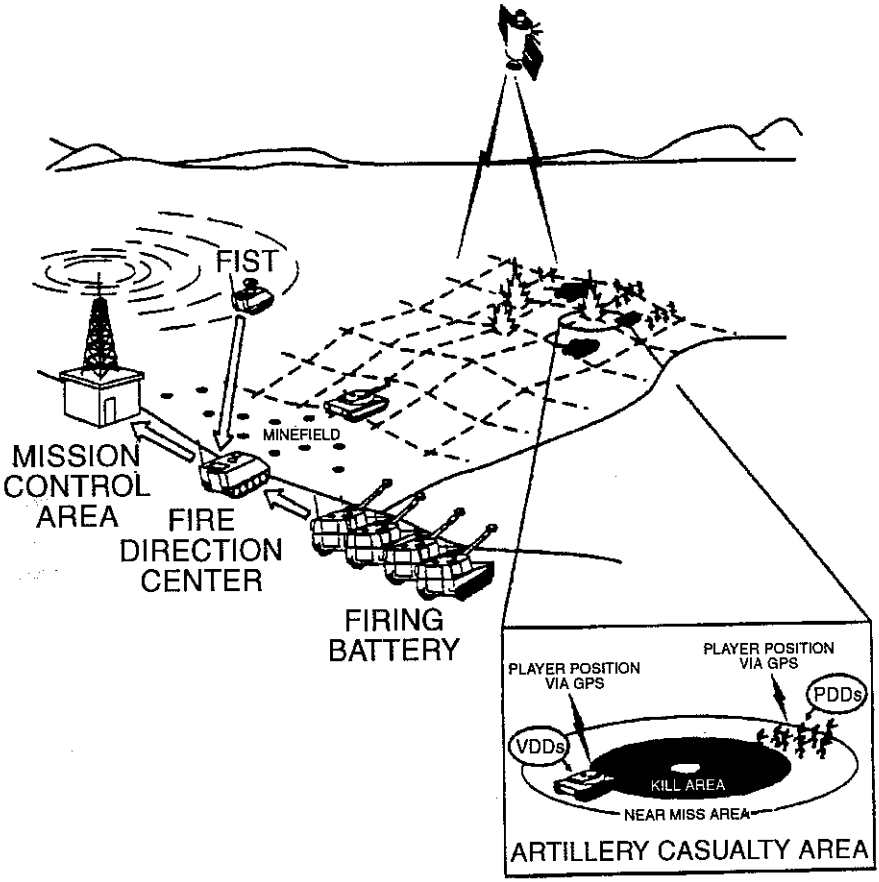
84. (1) Briefing, Brig. Gen. William G. Carter III, NTC cdr, [1992]. (2) Telephone conversation with Larry Graham, Field Artillery School CATIES project manager, 28 Jun 91. (3) Dastrup and Kaplan, CY 1990, p. 95.

85. (1) Dastrup and Kaplan, CY 1990, pp. 95-96. (2) Lt. Col. Anthony P. Callanan, USAF, "Navstar - Global Positioning System (GPS)," *ALFA Bulletin*, 30 Sep 87, p. 3.

Chart 6
SAWE-RF Indirect Fire Simulation



PDD - Player Detection Devices
VDD - Vehicle Detection Devices

Source: Headquarters, Department of the Army, Training Circular 25-6, Draft (Washington, D.C., 7 Feb 1994), p. 3-10.

GPS was composed of satellites that transmitted navigation messages. The messages were received via ground receivers, and the satellite system was so designed that at least four satellites were visible to a receiver anywhere on earth at a given time. The receivers computed how far they were from the satellites and solved the four unknowns of latitude, longitude, altitude or elevation, and time.[86]

The SAWE-RF system would simulate M74 antipersonnel and M75 antitank mines through an acoustical signal. The mines would emit a signal detectable by player detection devices within a 15-meter radius and by vehicles within a 10-meter radius. The receiver devices would be capable of assessing the effects of mine engagements and of communicating casualty information to the personnel or vehicle laser detectors which would activate the MILES kill alarm and transmit the data back to the Operations Center computers. The SAWE-RF system would define the casualty area for chemical munitions in a manner that allowed for the continuing lethal nature of chemical weapons. The downwind drift of contaminants would be simulated at speeds of 10 to 20 kilometers per hour, and would expand to 30 degrees off the centerline of drift from the point of contact. A chemical alarm would sound, and if the player devices did not record breathing through a surrogate canister-filter within 20 seconds, the soldier was declared killed. A whistle alert would sound to indicate an area weapons event; flash, bang, and smoke cues would follow.[87]

In March 1990, the Army approved the integration of the aforementioned MILES II system into the SAWE-RF/GPS program, to take advantage of a common contractor (Loral) and common program goals. When fielded, the SAWE-RF/GPS/MILES II would be a single tactical engagement training system. By integrating line-of-sight and non-line-of-sight functions, cost savings could be realized by using a standard design player and vehicle detector device, thus hopefully avoiding another experience like that of CATIES. At the end of 1993, the new training simulation system was still in the development and testing stages. The plans to field it worldwide had, however, been abandoned. For the time being, only the three maneuver training centers could expect to receive SAWE-RF/GPS/MILES II.[88]

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86. (1) TC 25-6 coordinating draft, 7 Feb 94, p. 3-10. (2) The $6 billion multi-service GPS program was managed by the U.S. Air Force. For a detailed discussion of the GPS see Callanan.

87. TC 25-6, coordinating draft, 7 Feb 94, pp. 3-9 to 3-10.

88. (1) Dastrup and Kaplan, CY 1990, pp. 96-97. (2) TC 25-6, coordinating draft, 7 Feb 94 pp. 3-9. (3) TES Master Plan, May 1993, pp. 5-4.

The Instrumentation System Upgrade

On the battlefield at the National Training Center, the MILES was linked with a special instrumentation system. Central to the NTC concept from the beginning had been the development of a sophisticated computer-based instrumentation system to collect, analyze, and integrate information from the battlefield. Volume I of this study related the history of the early development and testing of the instrumentation system at Fort Irwin.[89] The ambitious project to create an objective means of measuring the proficiency of units and the outcome of force-on-force maneuvers was fraught with difficulties from the beginning. The project's designation as a Small Business Administration "set aside" and developmental problems caused numerous delays. Although the Phase I instrumentation system had been scheduled for delivery in July 1981—before the first rotation—it was not until June 1983 that the Army's conditional acceptance of the 500 player system marked the end of the Phase I procurement effort. The design characteristics and the operation of the Core Instrumentation System (CIS) were discussed in Volume I of this study. Over the next ten years, the instrumentation system received a number of "upgrades" as laid out in the original concept. The basic design, however, remained the same.

The NTC instrumentation system, sometimes known as NTC-IS, was designed to provide unprecedented amounts of objective information to analysts watching computer terminals and television screens miles away from the battle. The instrumentation had a two-fold purpose. The first, already noted, was to collect, edit, and display in near real time a complete record of each training mission and provide relevant information to units after the battle. The second was to provide a historical database to be used to improve training techniques, organization, doctrine, and equipment effectiveness. The instrumentation in place in 1984 was relatively primitive compared to what NTC developers envisioned as the objective system. As soon as it seemed reasonably certain the NTC would remain a part of the Army's training system, efforts began to "upgrade" all the components of the system, including the Operations Center facility.

The NTC instrumentation system collected data in three ways: computer instrumentation; video monitoring; and communications monitoring.[90]

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89. See Chapman, *NTC*, Vol. I, pp. 57-79.

90. For a detailed discussion of the NTC instrumentation system as it existed in the mid-to-late 1980s, see NTC Vol. I, pp. 59-68. The instrumentation system was made up of three subsystems. The Core Instrumentation Subsystem (CIS) contained the computer-based training control system in the *(Continued)*

The key part of the system was the player kit or "B" unit discussed above. Those units were mounted on approximately 370 vehicles, although the computer could track up to 500 players. Operating in conjunction with the MILES lasers and detectors, the B units recorded events—such as firing, hit, kill, and use of radio—that occurred on the battlefield. About 100 "manpack" systems for individual soldiers were also used. The manpack systems could record hits, kills, or near misses, but could not identify the firer. Throughout Fort Irwin's vast training area were forty-four solar-powered radio towers, or "A" stations. The A stations provided the triangulation that provided position location.[91] The relay stations "polled" ground players every 5 seconds, helicopters every 0.5 seconds, and high performance aircraft every 0.1 seconds. When a vehicle was polled, it transmitted a range pulse which, if picked up by three A stations, could be used to locate the player to within 10 meters of his actual location. The RDMS analyzed the time difference from transmission to receipt. The relay stations "asked" the vehicles "where are you?" "Have you fired?" "Have you been hit or killed?" The queries were transparent to the vehicle crew. The polling was not perfect. From 10 to 30 percent of vehicles could be lost to the computer at any one time because of terrain masking, equipment malfunction, or other causes. The information collected was relayed to a "C" station atop Tiefort Mountain, the highest point in the principal maneuver area at Fort Irwin. The C station transmitted the data to the Operations Center facility, the so-called "Star Wars" or "Death Star" building, located in the heart of the garrison at Fort Irwin. There the vehicle showed up as a symbol on a computer screen—blue for the BLUFOR, red for the OPFOR, and yellow for chemical attacks. The symbols also varied so that a Bradley Fighting Vehicle could be distinguished from an Abrams tank. The computer then attempted to "pair" or match the shooter to the target by comparing the character of the vehicle and the time of the event. Often, however, a pairing could not be made owing to signal masking problems.

The NTC also had two fixed cameras on the tops of mountains, and portable cameras that moved to battle sites to film the battle on closed circuit television. Those pictures also were transmitted to the Star Wars building, where training analysts could watch the fight unfold. Concurrently,

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90. *(Continued)* Operations Center building on the Fort Irwin garrison. The Range Data Measurement Subsystem (RDMS) included MILES, the position location system and the other components of the system that gathered the data during the battles, that appeared on the screens in the CIS. The Range Monitoring and Control Subsystem (RMCS) was made up of the transmitters and relay stations in the field that sent the data to the CIS.

91. When four stations were used to determine position location, the process was known as multilateration.

analysts could listen to any of 90 radio networks to record critical transmissions and listen for security violations. Each unit down to platoon level had a controller assigned to it in the Star Wars building. The Operations Group controller had a counterpart field controller with the unit on the battlefield. The two controllers were in constant contact as to the status of the friendly and opposing forces.[92]

As noted in Chapter I, on 1 October 1984, Headquarters, Department of the Army requested that FORSCOM and TRADOC develop a five to ten year plan for the NTC. Several days later Brig. Gen. Edwin S. Leland, Jr., NTC commander, outlined for the Army Commanders' Conference, plans for future NTC development. Among the issues were improvements to the instrumentation system. That dialogue appears to have been the result of several forces. First, the original concept for the NTC had included a provision that the instrumentation evolve to take advantage of advancing technology. Second, and also discussed previously, plans were being made eventually to train three battalions simultaneously at the training center. Meanwhile the brigade headquarters would play an increasingly larger role in the training, and involvement of combat support and combat service support would also increase. The aforementioned heavy/light rotations created a requirement for more O/Cs. And plans were to add forward support, aviation, and field artillery battalions. Those plans meant more players had to be instrumented. Originally, plans had been to conduct actual brigade level exercises in FY 1990. In early 1988, that date was moved forward to FY 1993. At the same time, the associated instrumentation enhancements were moved up to FY 1993.[93]

In early 1988, the commander of the TRADOC Operations Group, Col. William A. West, in a memorandum to the commander of the Army Training Support Center at Fort Eustis, Col. M. E. Ekman, set forth his view that an interim system to support training at the NTC through FY 1992 was essential.[94] The instrumentation system was six years old and already fully taxed. He asserted that while a new operations center would remedy some of the weaknesses of the system, other problems could not wait five years for correction. An interim system, that would be fully compatible with the planned objective system, was necessary to provide more communications

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92. (1) Briefing, Brig. Gen. William G. Carter, [1992], Fort Irwin, Calif. (2) ARI Notebook, Oct 1989.

93. Memo thru Cdr CATA ATZL-TAN for CDR ATSC ATIC-RT, [1988], subj: Interim Instrumentation Requirements to Support NTC Operations Through FY 92.

94. The Directorate of Army Ammunition, Ranges, and Targets of the ATSC was the proponent for the NTC instrumentation at the time.

networks and better range coverage "to provide more positive training control and better use of available land assets." The Range Data Measurement Subsystem (RDMS), West maintained, should be immediately enhanced to allow tracking of at least 650 players with the subsequent replacement of the RDMS with a 1000-player system based on a Global Positioning System (GPS); the MILES needed to be modified to allow more player identification codes to be incorporated; four additional workstations needed to be provided in the Core Instrumentation Subsystem (CIS) in the new Star Wars facility; and the Range Monitoring and Control Subsystem should be expanded to increase the quality, coverage, and secure capability of the subsystem's transmitters and receivers.[95]

In the meantime, the NTC went ahead with plans to build a new Star Wars building. The upgrading of the instrumentation meant more and newer computers and thus demands for more space. In any case, the original Operations Center facility had been meant only for temporary use. In June 1986, four contractors answered a request for proposal. An evaluation board composed of representatives from the ATSC, Missile Command, and the NTC Operations Group chose Science Applications International Corporation (SAIC), the contractor for the instrumentation from the beginning, to relocate the Operations Center, replace the data processing suite and software, and integrate several major new capabilities. The Department of the Army awarded the contract on 15 September 1986. The contract specified the target date of 1 April 1988 for beginning the move to the new facility. That target date, as so often with NTC projects, proved to be much too optimistic.[96]

Early in 1988, SAIC notified the government that it could not meet the 1 April 1988 date and proposed that operating capability be delayed until 31 December 1988, with documentation to be delivered by April 1989. After a trip to the NTC to determine what the difficulty was, the CTC Program Director at the Combined Arms Center at Fort Leavenworth reported to the Combined Arms Training Activity commander that "SAIC did not order the Audio Distribution Assembly until 30 July 87." That item carried a 300-day lead time. SAIC claimed that the delays were being caused by government-directed changes in specifications. The proponent, the Army Ammunition, Ranges, and Targets Directorate at ATSC, insisted the changes had been made before the design review and acceptance. SAIC further asserted that there was a lack of access to the NTC facilities and

95. Memo, Col. West to Col. Ekman, [1988], subj: Interim Instrumentation Requirements. See fn 91.

96. TRADOC Deputy Chief of Staff for Training Significant Activities Report, ATTG-ZX, [1986]. The SAIC role in development of the original instrumentation system is discussed in NTC Vol. I, pp. 60-62.

equipment. Whatever the case, the delay would mean a cost increase of $3.2 million. Nevertheless, the Army accepted the December 1988 date for initial operational capability (IOC).[97]

The new IOC date came and went with software yet to be fully developed and integrated into the new system. In addition, Operations Group personnel had to be trained to use the new system once it was accepted. At that point, SAIC predicted an operational demonstration would be possible in February 1989. That date, too, came and went. Throughout 1989, serious management, performance, and technical problems continued to plague the Operations Center move and upgrade effort, despite TRADOC's intensive efforts at a resolution. In February, a TRADOC directed government "Red Team" management effort began in an attempt to have the new facilities operational by July. The investigative team's analysis revealed systemic problems with the contractor's technical approach that made the July 1989 date unattainable. In addition, the contractor's delays in submitting cost and schedule proposals for the required changes further delayed the project. By August 1989, the contract had undergone fourteen modifications and was sixteen months behind schedule. Government estimates projected contract completion no earlier than June 1990 with an additional cost of at least $14.4 million. In his final briefing to General Carl E. Vuono, Army Chief of Staff, TRADOC commander General Maxwell R. Thurman stated that completion of the new operations facility was not anticipated until August 1990, with final delivery of supporting documentation by the end of 1990. Meanwhile, in January 1989, a General Accounting Office protest of the NTC operations and maintenance (O&M) contract with SAIC was resolved in favor of the government, and in April General Electric Government Services assumed responsibility for operations and maintenance.[98]

The efforts to move the NTC core instrumentation system equipment to the new and permanent operations facility finally bore fruit during 1990. During the period 14 through 28 June, SAIC performed the physical cutover from the old operations center to the new center. After acceptance testing, the new center was put into operation in September 1990. The expanded system possessed the capability to support 1,000 players and as many as three battalion after action reviews. Twelve new workstations had been added, and coaxial

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97. (1) Trip Report ATZL-TAN, Capt. Steven Darnell, CTC Program Director, to Cdr CATA, 25 Aug 87, subj: End of Rotation 87-12 Visit to NTC. (2) Staff Semiannual Historical Report, Office of the Deputy Chief of Staff for Training, CY 88/I, pp. 91-92; CY 88/II, p. 80.

98. (1) Staff Semiannual Historical Report, Office of the Deputy Chief of Staff for Training, CY 89/I, pp. 90, 91. (2) End of Tour Report, Thurman to Vuono, July 1989. (3) Msg, Cdr TRADOC to HQDA, 152100Z Sep 89 subj: FY 89 Year End Execution-OMA.

cables replaced with fiber optic cables. The new system also had the capability to integrate voice and video data, the lack of which had plagued data collection from the beginning. Enhancements were made to all other aspects of the instrumentation system, except the Range Data Measurement Subsystem and the Spectrum Management Engineering and Control Subsystem. At the end of 1993, plans were to enhance the RDMS to accommodate more than 2,000 players. And as noted above, a position location system based on the GPS instead of the current triangulation was in the final stages of testing.[99]

Live-Fire Exercises

During each NTC rotation, every unit spent some time, usually four days, at the Live-Fire Range located in the northern-most part of Fort Irwin near Death Valley National Monument. The range ran east to west through a valley created by the rugged Granite Mountains to the south and lower hills to the north. Mechanical targets ran north and south of a dry lakebed called Drinkwater Lake.[100] During the live-fire phase of training, units used live ammunition against the two-dimensional plywood targets that replicated either a frontal or lateral configuration of vehicles or dismounted infantry. Exercise observer/controllers assessed kills on the targets through the MILES system. Units shot small arms, tank and artillery rounds, missiles, and rockets during both offensive and defensive, day and night, missions. A computer system located in a control bunker was used to track the live-fire exercises.[101]

The remotely-controlled plywood targets were located on bands, and popped up one row at a time to simulate an advancing Soviet Motorized Rifle Regiment. In early 1985 there were 397 vehicle targets and 120 dismounted infantry targets. Over the next eight years the range was continually upgraded, so that by the end of 1993, there were a total of 1,500 targets.[102]

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99. (1) Briefing Slides, SAIC, n.d. [late 1991]. (2) Msg, HQDA to distr, 251314Z Jul 91, subj: Result of 23 July 91 Combat Training Center General Officer Executive Committee (CTC GOEC) Meeting. Plans were for the objective upgraded instrumentation system to feature "data communications interfaces" instead of the older "B" unit. For a fuller discussion see "Combat Training Centers Instrumentation Systems Program (CISP), coordinating draft, February 1994.

100. No heavy vehicles or artillery were allowed in the lakebed itself because the brine shrimp that hibernated beneath the surface were an endangered species. Clancy, p. 219. Also near the live-fire range is the Leach Lake air-to-air and air-to-surface gunnery range, a dry lakebed that provided a major component of the bombing practice available to American and German aircrews. NTC Vol. I, p. 130.

101. Chapman, *NTC*, Vol. I, pp. 39-40.

102. By March 1988, the live-fire range had 660 targets; in 1990 there were 1100. ARI Notebook, pp. 100-101.

The computer had the capability to speed up or slow down the advance of the enemy based on the task force's success. In addition, killed targets did not reappear as the bands of targets moved toward the task force. The live-fire target lifters were standard Army lifters except that they were solar-powered rather than battery powered, to take advantage of Fort Irwin's nearly constant access to cost-free energy from sunlight. Targets were equipped with thermal signature systems (thermal "blankets") to allow engagements during reduced visibility for those weapons systems with thermal viewing devices.

Those responsible for the design and ongoing development of the live-fire range sought to create as realistic an environment as range safety regulations and funds would allow. Because the targets could not shoot back, BLUFOR casualties and damage were assessed subjectively by O/C firemarkers who also provided special effects to simulate the confusion of a real battlefield. The setting off of Hoffman charges replicated vehicle firings. Pyrotechnic devices indicated "steel on steel" hits. When killed the targets sent up heavy black smoke clouds to simulate burning tanks. Smoke also replicated the rising desert dust churned up by the advance of the enemy's vehicles. Some targets shot back with "Smoky Sam" styrofoam missiles to simulate Sagger anti-tank guided missile firings. Machine guns, rifles, the cannons of tanks and fighting vehicles, and several types of missiles used real rounds. Because of the cost of live ammunition, the firings of other systems were simulated by MILES laser devices fired against sensors on the targets.

The live-fire range also included minefields, concertina wire, and obstacles emplaced by the engineers. The mines were ceramic, but soldiers used real ammunition to clear them. Even chemical warfare was simulated with tear gas grenades, requiring soldiers to fight in MOPP (mission oriented protection posture) gear. One-fifth scale remote control aircraft (drones) replicating Soviet MIG 27s served as targets for air defense crews. The small aircraft flew 500-1000 meters in front of the task force during each daylight mission. The planes could be shot down with live ammunition, and were equipped with MILES sensors to indicate hits by Stinger anti-aircraft weapons. Air Force units also participated in the live-fire exercises. In fact, the Army complained that the opportunity to employ live ordnance caused the Air Force to commit too many aircraft to live-fire, leaving too few aircraft on ground alert to support force-on-force maneuvers. As with the force-on-force maneuvers, television cameras recorded unit action, and the computer generated and complied hit data.[103]

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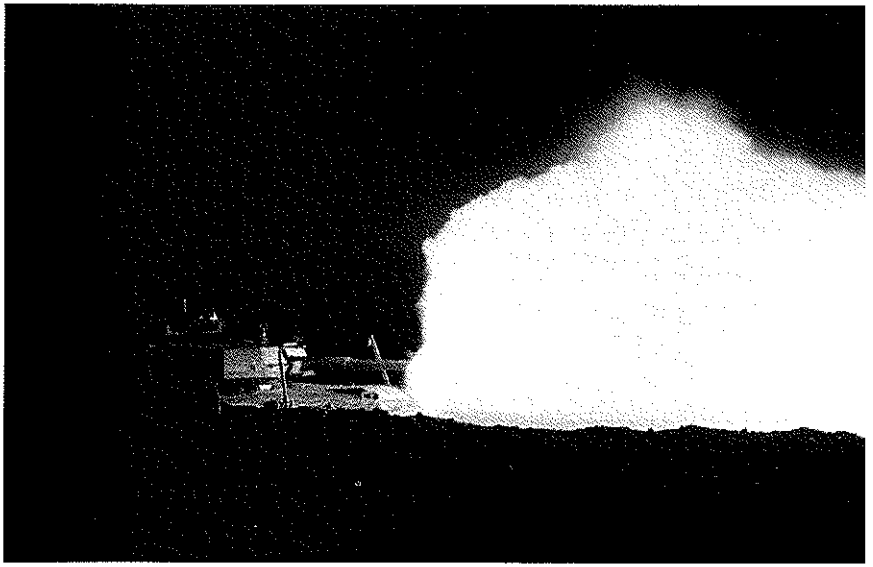
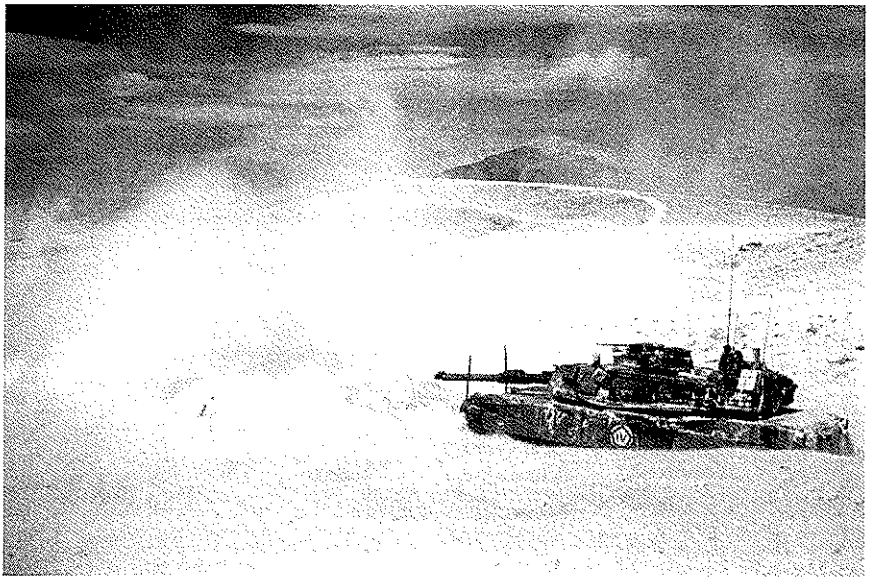
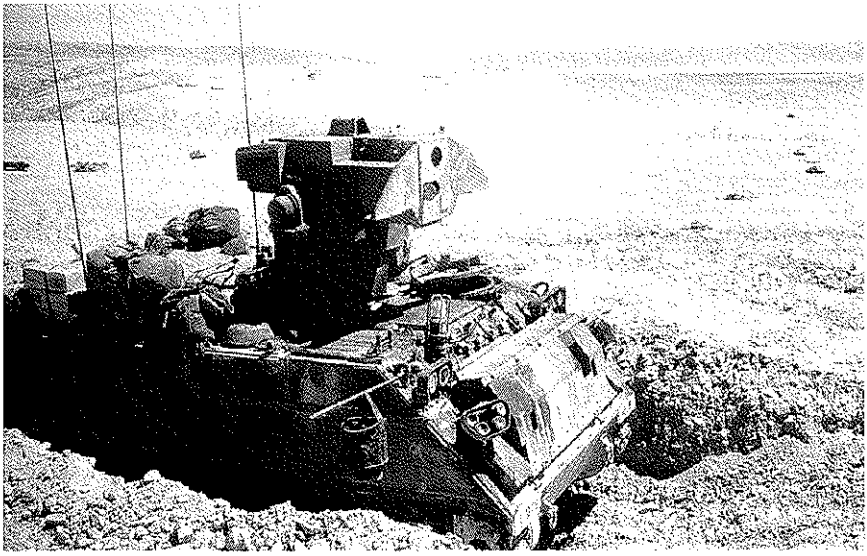
103. (1) ARI Notebook, pp. 100-101. (2) Briefing, Brig. Gen. Horace G. "Pete" Taylor, NTC Cdr, [1987]. (3) Issue Sheet ATSC-NTC-TSM, FORSCOM to HQDA, [1985], subj: NTC 5-10 Year Plan. (4) Clancy, pp. 214-21.



An M1 main battle tank of the 1st Infantry Division fires its 105-mm. gun during night live-fire exercises. The live-fire range featured more than 1,000 computerized pop-up targets to simulate a Soviet motorized rifle regiment.

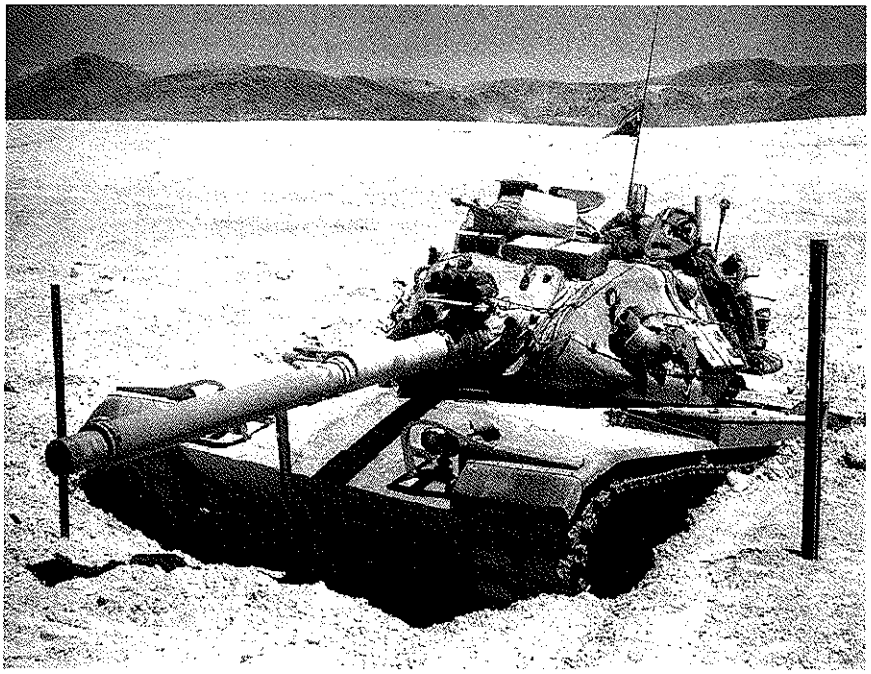


During live-fire exercises pyrotechnic firing devices "shot back" using Hoffman charges to simulate tank main gun fire. "Smokey Sam" styrofoam missiles simulated Sagger antitank guided missile firings and produced smoke to simulate hit and burning vehicles.

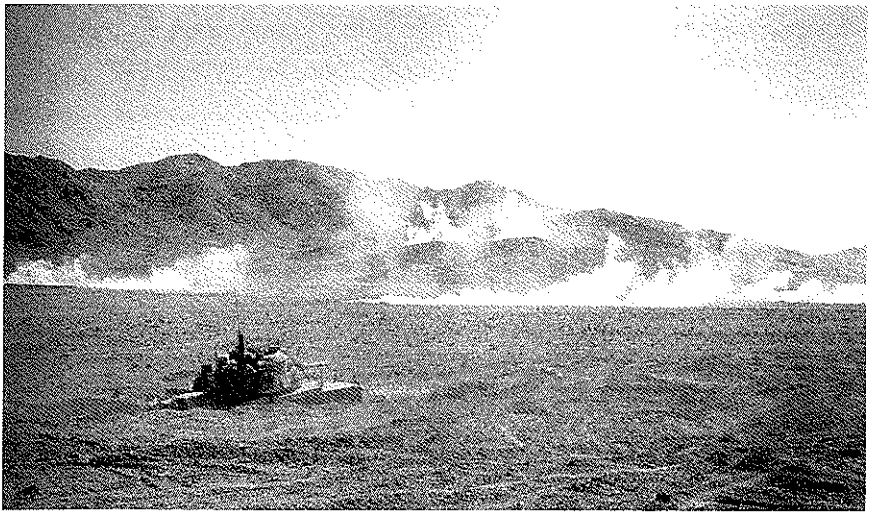


A wide variety of vehicles took part in the live-fire exercises at the NTC. Here an M981 Fire Integration Support Team Vehicle (FISTV) allowed artillery forward observers in armored and mechanized infantry units to locate targets and transmit data back to firing units. The M981 was part of the M113 family of vehicles.

As with the force-on-force maneuvers, 3rd Armored Cavalry Regiment M1A1 crews took part in the live-fire exercises in the NTC's northern corridor. This Abrams MBT is dug in, in a defensive position, to make it more difficult to target or observe.



Although the U. S. Army began retiring the M60-series MBT from all active duty tank units in the early 1980s, as late as May 1990 the M60A3 could still be seen participating in NTC live-fire exercises.



During live-fire exercises in the vicinity of Drinkwater Lake BLUFOR troops in an M60A3 shot at pop-up targets that simulated enemy tanks. At the NTC, live-fire exercises were conducted day and night for rotating units.

The live-fire exercises at the NTC, as elsewhere in the Army, presented a dilemma. Realism was the NTC's stock-in-trade; at the same time, safety considerations dictated that some situations differ from what likely would have occurred in actual combat. None of the NTC live-fire targets moved independently, because free moving targets too often caused maneuver units to shoot their own tanks. On the other hand, the lack of moving, three-dimensional targets meant diminished training opportunities for attack helicopters. No weapons systems were fired on the move, except from a stabilized firing platform. Tanks and Bradleys could not fire their main guns on the move unless turret stabilizers were on and functioning. Vulcan anti-aircraft weapons had to keep their guns at maximum elevation, and likewise could not fire on the move. The only flying targets that could be engaged were the radio controlled scale model MIG-27s. All other aircraft was considered to be friendly. One Senior Live Fire Task Trainer voiced his concern that he had no machine gun simulators. The machine gun simulators issued by the Army were propane-based and had been banned by the Surgeon General for use in a live-fire environment because they tended to blow up when hit. Safety was such an overriding consideration that anyone observing an unsafe or potentially unsafe act was required to command "check fire." In the last analysis, however, despite those detriments to realism, the NTC Live-Fire Range seemed to warrant author Tom Clancy's characterization of it as the "mother of all shooting galleries."[104]

Other Enhancements to Training

The National Training Center experience for soldiers was not solely instrumentation, MILES, and live-fire. Units also had the opportunity to test or develop many other skills necessary to force readiness. And training in those skills was not always simulated. For example, if a commander wanted a tank ditch dug, he had to send his engineers out to dig the ditch. If a soldier was injured in a battle, he had to be properly evacuated. If he died, his commander had to requisition a replacement. If orders for spare parts were not properly completed, the unit got no parts. If food was lost or incorrectly delivered, the unit went hungry. If radios were misused, the OPFOR was always ready to use "stolen" information. The concertina wire and other obstacles on the NTC battlefield were all too real and had to be cleared or breached. Damaged vehicles had to be removed. If a unit

104. (1) ROE, pp. 57-64. (2) Col. Burns interview, November 1990. (3) Clancy, p. 216.

failed to bring up ammunition, it did without. While mines and chemical contamination could not be real, the minefields had to be cleared as in actual battle, and soldiers had to maneuver on a "dirty" battlefield in MOPP gear—a convincing experience in the desert heat. So, while casualties at the NTC were not authentic, much of the training was.

Casualty Evacuation

Casualty evacuation at the NTC was a combination of simulation and the actual physical removal of casualties from the battlefield. When each soldier was issued his MILES equipment before deploying to the field, he received a printed casualty description card. The cards specified the type and extent of injury in the event the soldier was hit. A casualty card might read:

> Laceration, right hip and right calf, two inches deep. Lie down. You can talk but not walk, and you cannot assist the unit except by providing information.

Soldiers declared to be casualties were required to sit down, remove their helmets, insert a yellow key into the MILES harness to deactivate the system, and follow the directions on the casualty cards. Any soldier found "cheating" on MILES was subject to a $600 fine.

As task forces suffered casualties on the front lines, their medics evacuated the wounded to an aid station just behind the fighting. There, less serious injuries were tended to, usually in a tent set up in the back of a vehicle. Soldiers requiring attention beyond the battalion aid station were evacuated further to the rear to a more fully equipped brigade treatment station. Most of the time patients were brought in to the treatment stations in trucks because ambulances were in short supply, and the vast distances in the desert often meant a five-hour round trip.

Speedy evacuation was essential. In accordance with the NTC Rules of Engagement, unconscious litter patients had to be treated within two hours or they were ruled as having "died of wounds" (DOW). Less seriously injured litter patients had four hours to receive treatment. Litter patients could provide no assistance to the unit. Ambulatory patients had twenty-four hours to receive treatment, but some—depending on the injury—could provide assistance to the unit after first aid was completed. If a soldier's casualty card read "RTD" (return to duty), he was given first aid but not evacuated. In that event, the exercise controllers reactivated his MILES and he returned to combat operations. If a soldier's card read "KIA"

(killed in action), he was evacuated to the graves registration point and not allowed to return until after the current mission was over. All KIAs and DOWs had to remain out of the battle for a minimum of twenty-four hours, at which time they were returned to duty as filler personnel. When being transported, the fake casualties could be seated, but a sufficient number of litters had to be on hand for all litter patients. Likewise, casualties and KIAs had to be evacuated on a vehicle with sufficient cargo capability. A major problem for medical companies and patients alike was that too often "nobody knows where the aid station is." Even when evacuation was carried out without incident, all paperwork had actually to be completed and sent to the appropriate agency before the soldier could continue to participate. Failure to report casualties properly meant that the unit slowly eroded in manpower.[105]

Simulated casualties had to be cared for, evacuated, and replaced. Here an M113 serves as an ambulance.

105. (1) NTC ROE, pp. 26-28. (2) 1 Lt. Robert D. Lee. "Rotation to NTC," *Army Trainer*, Winter 1990, pp. 54-56. (3) Interview, TRADOC NTC Operations Group, NTC Observation Division with Capt. Jefferson Henderson, September 1991.

Smoke, Mines, and Obstacles

National Training Center leaders also attempted to ensure that the presence of smoke, mines, wire, and other obstacles was as realistic as possible. Engineer operations were heavily stressed, and the only engineer simulation was the use of dummy mines. Traditionally during maneuvers, tank ditches had been replicated by engineer tape and time delays imposed on attacking units to represent the time required to breach an obstacle. As noted previously, at the NTC, ditches, dirt berms, and fighting positions were actually dug. Explosives were not allowed. At the close of each mission, both BLUFOR and OPFOR were required to remove any obstacles and construction materials, and fill in tank ditches not needed for future missions.[106]

The BLUFOR employed mine clearing equipment that included the roller and plow shown here on an M1 tank. If such equipment were lost in the battle, rotating units lost much of their capability to breach minefields.

106. NTC ROE, p. 16.

The explosive effects of mines at the NTC was simulated when the O/Cs set off hand grenade simulators. Unprotected player personnel within 500 meters of a line charge were assessed as casualties. Units also employed the family of scatterable mines (FASCAM) artillery-delivered mines at the NTC. Should a unit fail to safely breach a minefield, casualties were assessed at 1 kill per 6 vehicles on a low-density minefield; 2 kills per 6 vehicles on a medium-intensity minefield; and 3 kills per six vehicles on a high-density minefield. FASCAM were marked by airbursts and yellow smoke.[107]

For the visitor to the NTC, one of the most visible characteristics of the battlefield was the presence of large clouds of smoke. And most of it belonged to the OPFOR. Doctrine and experience had long reflected the effectiveness of the use of smoke as an obscurant, especially in obstacle breaching and minefield clearing operations. Several studies had found, however, that rotating units' use of smoke ranged from nonexistent to only marginally effective. When the BLUFOR did use smoke, they too often failed to correctly measure wind direction and speed, an error that placed the smoke over their own forces, resulting in confusion of command and control and hampered movement. Smoke, too, could make the white engineer tape used to mark lanes through minefields, very hard to see. On other occasions, engineers did not call for smoke on the grounds that that was the responsibility of the maneuver units. In addition, artillery planners often underestimated the quantity of smoke rounds required for effective density and duration. But, as one observer put it:

> While rotating units rarely use smoke, the OPFOR has purchased stock in the corporation. Deliberate attacks often see heavy smoke placed as closely on top of the defenders as possible. This negates the "stand off" range advantage of some weapons and adds shock effect when a mass of infantry or armored vehicles emerges from a wall of smoke with its weapons on "rock and roll."[108]

Chemical warfare was also simulated at the NTC through use of tear gas and simulated persistent agents. If a unit moved through a

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107. Ibid., pp. 16-18.

108. A smoke screen 1,000 meters long, lasting for 30 minutes required 500 rounds. A mortar platoon carried only 528 rounds. (1) Woodgerd, pp. 164-166 (quotation, p. 166). (2) Capt. McClearn, Combined Arms Assessment Team Report 88-2-10 (Fort Leavenworth, Kan.: Center for Army Lessons Learned).

Soldiers rotating through the NTC often encountered "chemical" (tear gas) attacks and had quickly to don "mission-oriented protective posture," or MOPP, gear.

contaminated zone, O/Cs notified them of it. The unit was then required to don MOPP-IV gear including full chemical protection suits.[109] After the fielding of the German-made Fuchs ("Fox") NBC (nuclear, biological, and chemical) vehicle, it was used to survey the contaminated zone and report the results to headquarters. Rotating units had not only to fight in MOPP gear in desert temperatures, but contaminated units were moved to decontamination sites before being regenerated into the fight. Each player carried an NBC casualty card that identified his symptoms. As in the case of indirect fire and mines, observer/controllers assessed casualties from chemical agents. Visiting task forces faced chemical attacks during at least nine or ten missions during fourteen days in the field. National Training Center exercises contained such heavy emphasis on chemical warfare training partly because U.S. Army trainers recognized that the protection and decontamination skills that could mean life or death, atrophied rapidly. The other aspect according to Col. Patrick O'Neal, then OPFOR commander, was that "it is such a sinister thing, which causes a lot of anxiety in people."[110]

The Radio Networks

Perhaps the thing that surprised the first-time visitor to the NTC the most, was the activity on the 90 radio networks. Radios seemed to crackle everywhere. And nowhere was the excitement of participants in the NTC battles more evident. The edited 55-minute extract from a task force command network in the Appendix bears witness to that enthusiasm as well as to the confusion of the battlefield. The transcribed tape reveals perhaps better than anything else could, the reaction of tank crews as they encountered, among other things, "enemy air" (an OPFOR HIND-D helicopter) and shot it down; decontaminated a part of the task force; called for artillery fire; and watched an Air Force A-10 take out an OPFOR T-72 tank. The colorful jargon and code names served to provide some security on insecure nets, and also went far in explaining why it was sometimes so difficult for different elements of the task force to talk with each other, never mind talk to the Air Force. And radios to the OPFOR served as another weapon in their arsenal. Communication channels were cut, jammed, or faked. The

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109. There were four levels of MOPP apparel. MOPP-I designated the protective mask only. MOPP IV required the mask, rubber gloves, and the full protective suit.

110. (1) Wilson, "Training to fight in the Desert," *Jane's*, 23 Feb 91, pp. 258-59 (quotation). (2) NTC ROE, October 1987, pp. 23-25.

OPFOR intercepted the visitors' messages and substituted phony ones to confuse and harass.[111]

Supply

The U.S. Army Transportation Corps had a saying that "Nothing Happens until Something Moves." That epithet applied as much to training at the NTC as to actual combat. Despite simulated casualties, real soldiers needed real supplies: food, water, ammunition, medical supplies, fuel, repair parts, and construction materials. Failure of those items to be expeditiously requisitioned and transported to units in the field greatly increased the OPFOR advantage. Training at the National Training Center was a trial by fire for most combat service support units. As one senior forward support battalion trainer observed:

> Combat service support at NTC is totally different than garrison operations. The soldiers and leaders must have a sense of time distance factors and an understanding of the harsh environment. . . . The critical factor is that folks in the logistics community must realize the difference between supporting a unit that is deployed fully for combat operations as opposed to supporting a unit that is at home in garrison.[112]

The logistics rules of engagement at the NTC were probably the most comprehensive in the U.S. Army. Although some constraints did exist, the rules were intended to force units to practice logistics doctrine. That, however, was part of the problem. Research for a number of studies revealed that logistics training at unit home station was generally ineffective, so that at the NTC glaring deficiencies existed, primarily in the execution of doctrine. Whatever the case, combat service support (CSS) units were usually surprised at the level of reconstitution and ammunition "play" required. As one soldier put it, "there are no magic wands."[113]

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111. (1) ARI Notebook, pp. 92-121. (2) "Emulating the Battlefield," *IEEE Spectrum*, September 1991, p. 38.

112. Lt. Col. Scott interview, Summer 1990.

113. (1) Ibid. (2) NTC ROE, 5 Oct 87, pp. 26-37. (3) Frank N. Roberts, "Logistics in Desert Operations: Lessons Learned from the National Training Center" (MMAS Thesis, CGSC, 5 Jun 87), p. iii. Numerous studies of logistics and combat service support at the NTC have been completed. Roberts' is the most complete of these to date. The manual for CSS at battalion level was FM 71-23, *The Tank and Mechanized Infantry Battalion Task Force.* The manual for desert operations was FM 90-3, *Desert Operations.*

National Training Center officials learned early in the center's history that even if CSS units were adequately trained to provide support at home station, the logistical techniques and procedures learned there often did not apply in the vast terrain of Fort Irwin. Combat units fighting in depth were soon crippled without proper resupply. When resupply did come, it often took all night, and exhaustion took its toll in the next day's battles. By the close of 1984, a relatively new technique to make resupply work was in use by some units. Under that concept called "logistics packages" or LOGPACS, the gathering and movement forward of supplies was centralized at battalion level. Supplies were brought forward to a forward pickup point called a "logistics release point" where the company team first sergeant picked them up, employing a single convoy (Chart 7). The new system limited the loss of vehicles and reduced the risk of giving away the BLUFOR position. The system proved far superior to a decentralized system in which each team gathered its own supplies and transported them forward. By the late 1980s, all units adopted the LOGPAC system while at the NTC.[114]

Class I (food and water) supply and resupply began when personnel from the brigade Forward Support Battalion picked up the supplies at the Fort Irwin main post. It will be remembered that use of dining facilities at Fort Irwin was prohibited; unit mess teams deployed with the rotating units. No unit elements were allowed to remain in a garrison setting. The forward support battalion delivered the sustainment items to the battalion through the brigade support area in the field. Company personnel officers or first sergeants provided a daily headcount to the field trains. The headcount informed the mess section of daily personnel strengths and reflected changes in task force organizations, information that was then applied to ration preparation for each unit's logistics package. The LOGPACs then departed from the field trains to the logistics release point, prior to movement to each company or unit location. The weak point in the system was that without careful monitoring, separate platoons and other attachments—such as scouts and mortar platoons—might be overlooked. Comments from many veterans of Fort Irwin and of Operation Desert Storm suggest that being overlooked at mealtime might not have been all bad. In the field, soldiers were fed "meals ready to eat"— always referred to as MREs—which had replaced the older C-rations—and were quickly dubbed "meals rejected by everybody." The meals were better served hot, but dropping

114. Chapman, *NTC*, Vol. I, p. 107.

them into hot water caused the chemicals on the plastic containers to come off into the water which when used for coffee, often made people ill. Sometimes another solution was to heat the MREs on the back grill of an Abrams tank, the hot manifold of a helicopter, or the hood of a HMMWV.[115]

During maneuvers or actual combat in the desert, heat-related medical problems were a constant threat. Training at Fort Irwin, with temperatures sometimes reaching nearly 130 degrees, was certainly no different. Surface water was extremely scarce on Fort Irwin, but well water was plentiful. The installation drew approximately 2,000 acre-feet of drinking water each year from 11 domestic water wells. Fortunately for Fort Irwin residents and visiting troops, water levels had remained static for as long as five years of drought. Unfortunately, the water contained excessive amounts of fluoride and had to be treated before use. And the logistics of getting the water to the units in the field made conservation and discipline necessary. Water trailers came forward daily to resupply each unit. The full 5-gallon cans in which water was stored could be exchanged for empty ones only if sufficient cans were on hand in the task force. Commanders had found that the availability of ice was a morale factor, but the logistics officer was not always able to obtain it.[116]

Class III (petroleum and other fuels and lubricants) supplies moved the rotating task forces. Without it, a mechanized infantry or armor unit was helpless. As the NTC matured, and the Abrams tanks and Bradley Fighting Vehicles were fielded, logistics planners found that those systems had a much greater fuel consumption rate than the older M113 personnel carriers and the M60-series tanks. Vehicles were filled up ("topped off") at the main post prior to the long road march to the field. Unit estimates for consumption during the initial road march ran as high as 50 percent of vehicle capacity. Vehicles were usually refueled at refueling stations at the assembly area before occupying positions for the first combat mission. In the field, fuel had to be available on a daily basis. For that reason, fuel tankers accompanied all company LOGPACS. In the event of fuel or tanker shortages, fuel was supplied in accordance with the priorities set down in the operations order.[117]

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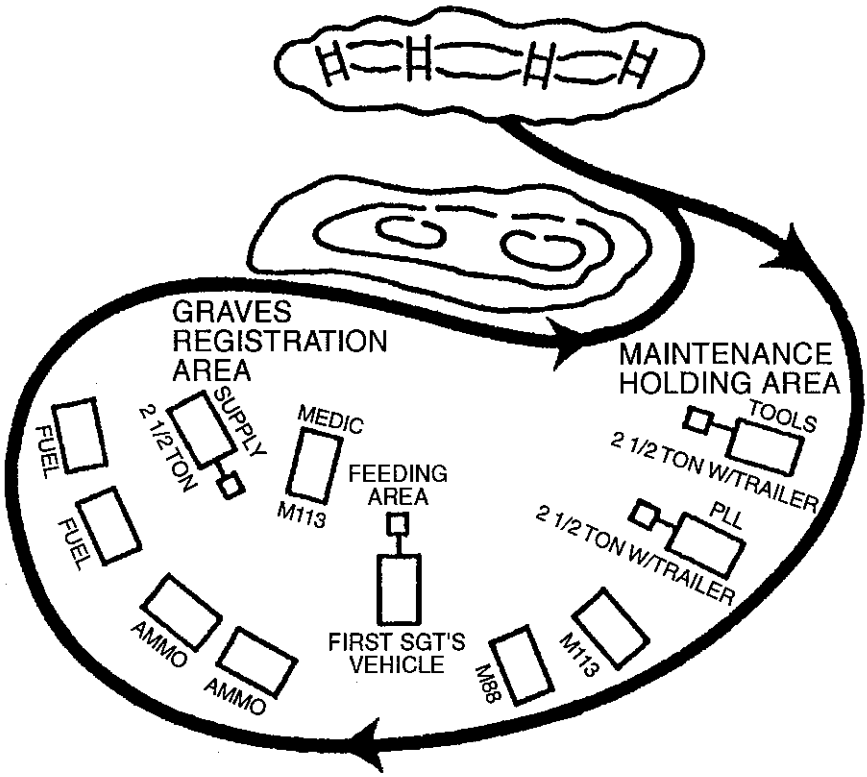
115. (1) Roberts, *Logistics*, pp. 48-49. (2) Ken Flynn, "Mojave Desert Special: Chicken a la King, Army Style," UPI Texas NewsFeature, 28 Oct 87.

116. (1) Roberts, *Logistics*, pp. 49-50. (2) National Training Center, "Desert Tortoise Biological Assessment for the Current Mission at the National Training Center, Fort Irwin, California," June 1991.

117. Roberts, *Logistics*, pp. 51-52.

Chart 7
LOGPACK Layout



Source: Lt. Col. Alan R. Cocks, "Objective NTC: Some Ideas on How to Get There from Here," Student Essay, U.S. Army War College, Carlisle Barracks, Pa. February 1986.

For obvious reasons of cost and safety, live ammunition (Class V) was not used at the NTC during force-on-force maneuvers. NTC planners, however, continually searched for ways to improve training for CSS ammunition supply elements. Task Forces training at the NTC received ammunition—representative of their basic load—in the field trains prior to the start of the exercise. Some units received simulator training ammunition such as blank cartridges, Hoffman charges, and ATWESS (Anti-tank Weapons Engagement Simulation System) rounds; other units received "paper ammunition." Personnel in the field trains were required to paint ATWESS rounds prior to issue or transport to the field. Paint in various colors served to differentiate between anti-tank weapons such as TOW, Stinger, Chaparral, and Dragon missiles (i.e. red for the TOW, green for the Dragon). The O/Cs issued paper ammunition to unit support personnel of units equipped with Bradley and Vulcan. When a crew fired a weapons system for which paper ammunition had been issued, the paper representing the amount of ammunition fired was returned to the O/Cs.

All ammunition was treated as if it had the same weight and cube as the rounds it represented; i.e. one Hoffman charge equaled one tank main gun round. All simulated ammunition had to be handled by as many personnel as would be required actually to move the real thing. Thus, a soldier who could ordinarily lift only one tank main gun round would be allowed to lift only one Hoffman round. Dismounted soldiers could not carry more than two Dragon, or one TOW, or two Stinger ATWESS cartridges on their person. Vehicles could not exceed their actual carrying capacity in moving simulated ammunition. If the O/Cs declared vehicles carrying ammunition—as well as other classes of supply—catastrophically destroyed, the vehicles had to undergo complete replacement procedures before cargo could be delivered. When a vehicle was destroyed, its cargo was also considered destroyed and had to be replaced. As in actual combat, the ammunition supply system had some problems. Packages of ammunition brought forward often did not meet the companies' needs. For example, tank teams with an infantry platoon attached often received little or no small arms ammunition. In like manner, antiaircraft missiles often went to companies or teams that no longer had such units attached, due to task force reorganization.[118]

Supply of repair parts, medical supplies, and construction materials took place in a similar manner as that of food, water, fuel, and ammunition. And all supply systems at the NTC had problems ranging from mild to

118. NTC ROE, pp. 32-35.

severe. The breakdown of one system during a mission always affected several others. For example, maintenance of combat and transportation vehicles depended on the availability of repair parts; resupply, in turn, depended on efficient and well-maintained transportation assets. Experienced logistics observer/controllers generally agreed that given the cost of each rotation and the compressed training time, the primary focus had to be on the tactical aspects. At the same time, they lamented the lack of emphasis on supply and logistics, a situation that meant a decrement in training for CSS units. A chief of the CSS trainer team expressed his belief that a major problem was that the S-3 (operations officer) of the typical rotating unit did not involve CSS elements in planning and in preparation of the operations order. At the same time, CSS personnel lacked aggressiveness in getting involved. As a result, CSS units did not understand the commander's intent. In addition, CSS units tended to wait for a change of mission to do their jobs. "So I lose a $2 million tank for want of a one-hour generator repair job."[119]

A breakdown in combat service support was more difficult for the O/Cs to assess or quantify than were things like poor gunnery performance which had a laser-based evaluation system. But the effects of poor CSS had at least as serious an impact on the performance of tactical units. Field Marshall Erwin Rommel had perhaps put it best:

> The first essential condition for an Army to be able to stand the strain of battle is an adequate stock of weapons, petrol and ammunition. In fact, the battle is fought and decided by the quartermasters before the shooting begins. The bravest men can do nothing without guns, the guns nothing without plenty of ammunition; and neither guns nor ammunition are of much use in mobile warfare unless there are vehicles with sufficient petrol to haul them around. Maintenance must also approximate in quantity and quality to that available to the enemy.[120]

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119. Lt. Col. Vona interview, 30 Mar 90. Lessons learned in the CSS arena are discussed in greater detail in Chapter VIII.

120. Rommel, quoted in Martin van Creveld, *Supplying War: Logistics from Wallenstein to Patton* (Cambridge: Cambridge University Press, 1991), p. 200.

After Action Reviews, O/Cs, and Take Home Packages

Reviews of unit performance following each mission and each rotation, the observer/controller network, and the records that rotating units carried back to home station were the heart of the NTC concept. The after action reviews, nearly always called "AARs," which were conducted by the O/Cs, were arguably the major single influence on the revolution in training that took place in the U.S. Army in the more than twenty years following the end of the Vietnam War. By 1993, the AAR process was firmly in place throughout the Army as an evaluation tool, but it was at the NTC that AARs of this type were begun as a formal process, and it was there that the process matured. The following discussion is based only on the NTC experience. As for the take home packages (THP), successful use was slow in coming. NTC planners and developers continually sought ways to make THPs more effective in the improvement of home station training.

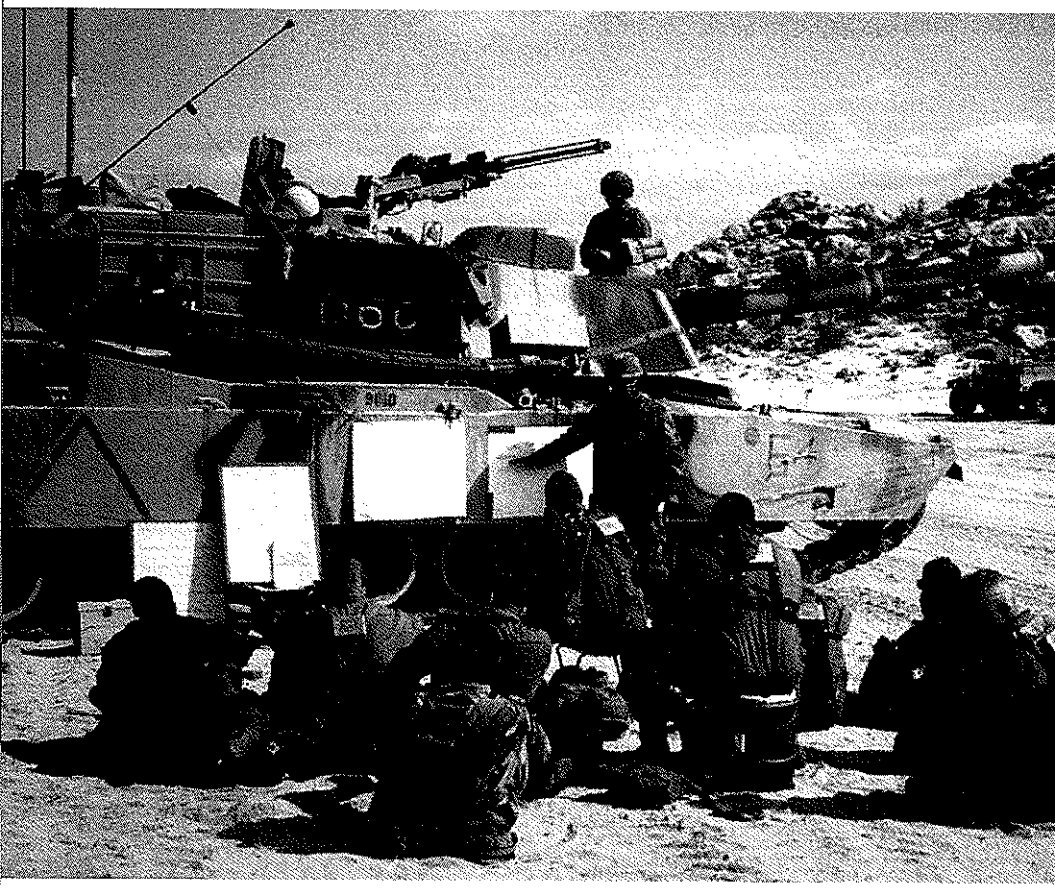
An O/C conducts an after action review in the live-fire area for a tank platoon of the 4th Infantry Division.

The NTC observer/controllers conducted AARs at platoon, company, and battalion task force levels, as well as for supporting elements. Data—both objective, computer-gathered information and subjective field observations gathered by video cameras and the O/Cs—were fed to the operations center to be analyzed, even as the battle continued. Training analysts isolated significant events which had affected the outcome of the battle and attempted to determine the doctrinal causes for failure on the battlefield. Violations of tactical doctrine were noted. The seven "battlefield operating systems" (BOS) served as a framework for each AAR.[121] Within four hours after an exercise, specially equipped, air-conditioned vans

After action review in the field. The commander is using the side of the vehicle as a blackboard.

121. Until June 1993, the Army identified the functions of the battalion task force as follows: command and control; maneuver; intelligence; mobility, countermobility, and survivability; air defense; fire support; and combat service support. At that time the Army revised the BOSs as follows: battle command; maneuver; intelligence; mobility and survivability; air defense; firepower; and logistics. The earliest version of the BOS included a separate category for nuclear, biological, and chemical (NBC) warfare. NBC was later included in mobility, countermobility, and survivability. Department of the Army, HQ U.S. Army Combined Arms Command, Combat Training Centers Instrumentation Systems Program, Army Training Support System, Fort Eustis, Va., February 1994, p. A-7.

reached the battlefield. Each van received, via microwave, edited video tapes and computer graphics featuring highlights of the latest battle. Tapes of radio communications were also recovered for use in the AARs. The O/Cs went through the operation with the task force leaders and explained step by step what was done right or wrong according to doctrine. Leaders at all three levels could analyze the results of their actions and develop approaches to improvements before the next battle.[122]



At the end of a mission, NTC observer/controllers conduct an after action review for a BLUFOR platoon.

122. (1) NTC Briefing, March 1986. (2) General Gordon S. Sullivan, "No More Task Force Smiths," *Army*, January 1992, p. 26.

The U.S. Army termed the AAR process "discovery learning," a phase apparently coined by TRADOC commander General William R. Richardson. NTC commander Brig. Gen. William G. Carter III believed that "75 percent of all learning occurs at the Daily After Action Review.... This learning process has markedly changed our Army. Now leaders at all levels are active players and must be professionally competent because they always have the opportunity of being questioned."[123] More than one battalion commander found the AAR to be "brutally honest." A reporter characterized the AAR as a "military group therapy session." Another observer termed an AAR session, "a warfare class for the MTV generation."[124] After action reviews also included debriefings by the OPFOR to provide what a chief of the TRADOC Operations Group termed "ground truth."[125] Another reporter perhaps came closest to describing the contribution the AAR had made to training what the Army believed to be the best trained army ever:

> After Col. Harmeyer [chief of the Operations Group] finishes the After-Action Review preliminaries, he invites questions from the audience. The first soldier to raise his hand is a young lieutenant, who with one sentence reveals how the National Training Center, and specifically the review sessions, have revolutionized the Army.[126]
>
> "Sir," the young lieutenant begins, "I don't really think the Commander made clear exactly what his intent was."
>
> After a moment's uncomfortable silence, Gen. Barry McCaffrey, then commander of the 24th Infantry Division, speaks up. "That's a good point," he acknowledges. "Getting our purpose across is key."
>
> Suffice it to say that 10 years ago, a young Army officer was just as likely to commit hara-kiri as to openly criticize his commanding officer.

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123. Brig. Gen. Carter, NTC Briefing, Fort Irwin, Calif., 1992.

124. MTV=Music Television.

125. J. R. Wilson, "National Training Center," *Janes*, 23 Feb 91, p. 261.

126. Col. George Harmeyer, Chief of the Operations Group, in the early 1990s.

Brig. Gen. Carter added: "That willingness of junior officers to question their superiors, and of superior officers to admit mistakes in front of their junior officers, has led to a totally different Army culture."[127] Brig. Gen. Paul Funk, NTC commander from September 1988 to October 1989, put it somewhat differently:

> The AAR has been the most important principle in terms of making a difference in our training. So we have to provide them feedback and we have to give it to them full bore. But, at the same time, we have to do it to enhance their performance, not to say "Ah, you screwed up" or "I got you," and all of those kinds of things.[128]

As important as after action reviews were to NTC training, their effectiveness owed almost everything to the exercise observer/controllers. The O/Cs' role in numerous facets of the NTC has already been documented in this study. Their contributions, however, could scarcely be overstated. They provided the glue that held the NTC concept and organization together. The O/Cs were literally the soul of the National Training Center. As noted previously, the NTC's master trainers were supplied by the TRADOC Operations Group. Some served as analysts in the operations center, while others served in the field with each rotating battalion—down to platoon level. There was an O/C for every staff and key leadership position. Each officer and senior noncommissioned officer who served as an O/C had to have experience in the branch he would represent and at the job level he would perform. For example, a scout platoon O/C would already have been a scout platoon leader. Unlike OPFOR personnel who were chosen at random from throughout the Army, the O/Cs were hand-picked.[129]

The observer/controllers were the coaches and trainers in the field, and they were present twenty-four hours a day with their unit counterparts during training. Even before a unit arrived at Fort Irwin, O/Cs conducted briefing visits at home station. The exercise controllers observed and analyzed unit performance throughout the planning, preparation, and execution of all missions at the NTC. The O/Cs were responsible for ensuring that the MILES equipment was in working order and being properly used. They

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127. James Kitfield, "Desert Showdown," *Government Executive*, September 1992, p. 23.

128. General Funk interview, Fall 1989.

129. Chapman, *NTC*, Vol I, pp. 71-73 gives an account of the functions of the O/Cs in the NTC's early days.

also served as a collection source for nonquantifiable data—that is any activity the instrumentation system could not monitor and record. The O/Cs' functions as recorders of aviation and artillery firing and chemical warfare effects have already been noted. They also recorded logistical operations, obstacle effects, recovery of vehicles and casualties, and personnel replacement. The O/Cs contributions during the AARs included the notes an O/C made in the field. Those notes came back to haunt the commander during the AAR. In a Combined Arms Center-sponsored program, O/Cs also served as mentors at the NTC for officers designated for battalion and brigade command.[130]

One observer of training at the NTC described the observer/controllers he witnessed in action:

> Part mentors, part alter egos and full-time shadows, the observer-controllers are the Army's institutional memory. They have seen it all at the National Training Center. While commanders wrestle with sleep deprivation, the often impenetrable fog of battle and constant harassment by the enemy, the observer-controller is there to make sure they learn from the experience. It's a little like having a personal trainer and coach in your face 24 hours a day while you are trying to run a marathon.[131]

In the words of a former chief of the Operations Group, "the melding of the power of the instrumentation system . . . and the battlefield observation of the O/Cs give a depth of understanding as to unit performance not exercised anywhere in the world except at NTC."[132]

The original NTC concept had included the preparation of "take home packages" (THPs) designed to aid commanders at the company and battalion level in the design of training programs to remedy training deficiencies identified at the NTC. Preparation of THPs was another responsibility of the O/Cs. The THP contained three categories of information. First, there were the videotaped summaries of the after action reviews that highlighted findings from each live-fire and force-on-force exercise a unit had participated in. Units also received tapes of each battle. Second, there

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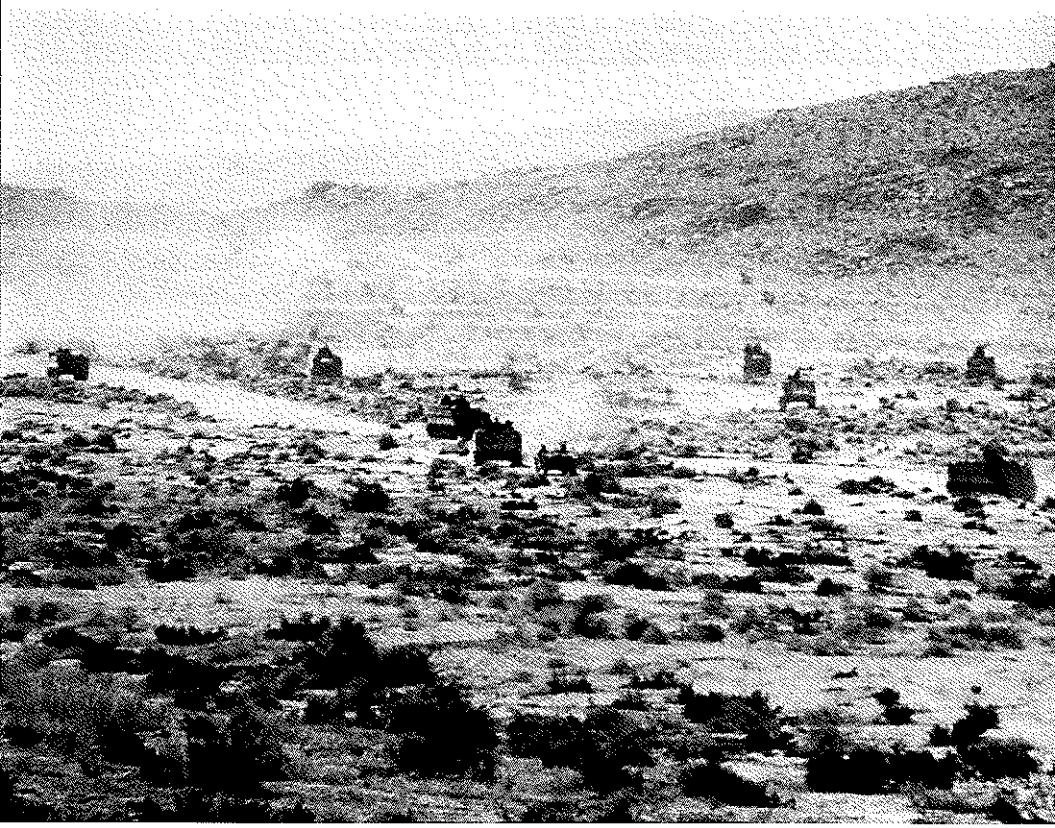
130. (1) NTC Briefing, n.d. (2) NTC Vol I, pp. 71-73.

131. Kitfield, "Desert Showdown," *Government Executive*, September 1992, p. 21.

132. William L. Shackelford, "NTC Perspectives," [A paper prepared for BDM Corp.], 1986. Shackelford was chief of the Operations Group from January 1882 until September 1984.

were diagnostic results of the NTC experience and evaluations of current training programs and future training needs. The latter was based on O/C comments and descriptions of how unit behavior was consistent with doctrine and how it had failed to conform to doctrine. Last, the THP contained map overlays and the graphic and numerical data reflecting the results of the battalion's encounters with the OPFOR (gunnery tables, casualty figures, equipment loss tables, etc.).

To prevent gamesmanship and promotion concerns as much as possible and to preserve the NTC as a training rather than a career enhancing experience, the THPs were "sanitized." That is, only the task force received copies of the videotapes. The brigade commander and the task force commander received copies of the written portion of the package. In addition, copies of the THPs with all identification removed were provided to the Combined Arms Center and the Army Research Institute for the Behavioral



BLUFOR vehicles and crews maneuver near Whale Gap.

and Social Sciences to make possible the analysis of collective data. That, at least, was the concept. From the beginning, complaints about the packages were frequent. Throughout most of the 1980s, the videotapes were on standard Army 3/4-inch tapes; most units had 1/2-inch tape players. Some units did not have the necessary workstations to effectively use the written data. Lack of standardization and frequent changes in format made collective data analysis across rotations difficult. The struggle at the NTC to establish an effective data analysis and lessons learned system is examined in detail in Chapter VIII.[133]

Those, then were the "tactics, techniques, and procedures," the rules, the weapons, the technology—the pieces of the puzzle—that came together to create the National Training Center experience for rotating units. Battlefield realism was, arguably, as great as possible given the limits of existing technology and safety considerations. At the close of 1993, some problems remained. But the U.S. Army remained dedicated to the evolution of the NTC, as well as the other combat training centers, as the facilities that provided the capstone events in Army training.

133. Chapman, *NTC*, Vol I, pp. 105-06.